REMARKS

This amendment is being filed in response to the Office Action dated March 31, 2003. For the following reasons, this application is in condition for allowance and the case should be passed to issue.

No new matter is introduced by this amendment. The amendments to claims 1 and 2 merely correct minor informalities.

Claims 1-20 are pending in this application. Claims 19 and 20 have been withdrawn pursuant to a restriction requirement. Claims 1-18 have been rejected.

Rejections Under 35 U.S.C. § 112

Claims 1-18 was rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. The Examiner alleges that the term "supersaturated" is a relative term, which renders the claims indefinite. This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

Contrary to the Examiner's assertion, supersaturated is a well-defined term. Supersaturated is not a relative term. One of ordinary skill in this art would know what is meant by supersaturated, as indicated by the attached dictionary definition (*Random House Webster's Unabridged Dictionary, 2d ed., p. 1910*) and chemical dictionary definition (*Hawley's Condensed Chemical Dictionary, 14th ed., p. 1061).* For the Examiner's convenience, an excerpt from a chemical textbook is provided explaining the difference between unsaturated, saturated, and supersaturated solutions (*Chemical Principles With Qualitative Analysis, pp. 283-85*). Furthermore, the instant specification teaches the requisite degree of dopant concentration to provide supersaturated source/drain extensions

(page 7, lines 1-3; page 9, lines 21-29; FIG. 4-6). Clearly, the rejection under section 112 is improper and should be withdrawn.

Claim Rejections Under 35 U.S.C. § 102

Claims 1-3 and 5 were rejected under 35 U.S.C. § 102(b) as being anticipated by Bai (U.S. Patent No. 5,889,331).

Claims 1-3, 6, and 7 were rejected under 35 U.S.C. § 102(e) as being anticipated by Murthy et al. (U.S. Patent No. 6,235,568).

These rejections are traversed, and reconsideration and withdrawal thereof respectfully requested. The following is a comparison between the present invention as claimed and the cited prior art.

An aspect of this invention, per claim 1, is a method of manufacturing a semiconductor device comprising providing a silicon-containing substrate having an upper surface. The silicon containing substrate comprises a gate electrode formed on the upper surface of the substrate with a gate insulating layer therebetween. The gate electrode has an upper surface and opposing side surfaces. Source/drain regions are in the substrate spaced apart from the gate electrode. Supersaturated dopant concentration source/drain extensions are formed in the substrate between the source/drain regions and the gate electrode. Metal silicide contacts are formed on the upper surfaces of the gate electrode and the substrate in a manner sufficient to maintain the supersaturated dopant concentration in the source/drain extensions.

The Examiner asserted that Bai and Murthy et al. teach a semiconductor substrate with a gate electrode, source/drain regions, and nickel silicide contact regions formed in a manner sufficient to maintain the dopant concentration in the source/drain extensions.

Bai and Murthy et al., however, do not teach forming supersaturated dopant concentration source/drain extensions in the substrate between the source/drain regions and the gate electrode, and forming metal silicide contacts on the upper surfaces of the gate electrode and the substrate in a manner sufficient to maintain the supersaturated dopant concentration in the source/drain extensions, as required by claim 1.

Murthy et al. teach implanting dopant in the range of approximately $1x10^{20}$-$2.5x10^{21}/cm^3$ in the N-tip regions 212 and in the range of approximately $1x10^{20}$-$5x10^{21}/cm^3$ in the P-tip regions 216 (column 5, lines 3-16 and lines 33-38). Murthy et al., however, teach that the dopant in the N-tip and P-tip regions is diffused out from the implant region when the implants are subsequently annealed (column 5, lines 16-18 and lines 37-40; and column 6, lines 46-53). Thus, Murthy et al. do not maintain supersaturated dopant concentration in the source/drain extensions, as required by claim 1.

The section of Murthy et al. cited by the Examiner as teaching the claimed dopant concentration in the source/drain extensions (column 6, lines 20-30), actually teaches the implanted dopant concentration in the source/drain regions, not the extensions. But, once again, Murthy et al. teach that the dopant is subsequently diffused out from the implant region in an annealing step (column 6, lines 27-29 and lines 46-53). In addition, Murthy et al. teach additional high temperature processing steps of the semiconductor device before the silicide contacts are formed. For example, Murthy et al. disclose forming spacer layer 218 at a temperature of approximately 800 °C (column 5, line 60 to column 6, line3).

Rather than teaching that the dopant concentration is maintained in the source/drain extensions, as asserted by the Examiner, Murthy et al. **explicitly teach diffusing the dopant** out from the source/drain regions and source/drain extensions. It is clear that the source/drain extensions in the Murthy et al. device are not supersaturated when the silicide contacts are formed.

The factual determination of lack of novelty under 35 USC § 102 requires the disclosure in a single reference of each element of a claimed invention. *Helifix Ltd. v. Blok-Lok Ltd.*, 208 F.3d 1339, 54 USPQ2d 1299 (Fed. Cir. 2000); *Electro Medical Systems S.A. v. Cooper Life Sciences, Inc.*, 34 F.3d 1048, 32 USPQ2d 1017 (Fed. Cir. 1994); *Hoover Group, Inc. v. Custom Metalcraft, Inc.*, 66 F.3d 299, 36 USPQ2d 1101 (Fed. Cir. 1995); *Minnesota Mining & Manufacturing Co. v. Johnson & Johnson Orthopaedics, Inc.*, 976 F.2d 1559, 24 USPQ2d 1321 (Fed. Cir. 1992); *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051 (Fed. Cir. 1987). As explained above, Bai and Murthy et al. do not disclose forming supersaturated dopant concentration source/drain extensions in the substrate between the source/drain regions and the gate electrode, and forming metal silicide contacts on the upper surfaces of the gate electrode and the substrate in a manner sufficient to maintain the supersaturated dopant concentration in the source/drain extensions, as required by claim 1. Therefore, Bai and Murthy et al. do not anticipate claim 1.

Applicant further submits that Bai and Murthy et al. do not suggest the method of claim 1.

Claim Rejections Under 35 U.S.C. § 103

Claims 8 and 9 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Murthy et al. in view of Tsukamoto (U.S. Patent No. 5,399,506). This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

The Examiner acknowledged that Murthy et al. do not disclose employing laser radiation with the specific energy as claimed. The Examiner relied on Tsukamoto to provide a teaching of pulsed laser irradiation of source/drain regions. The Examiner concluded that it would have been obvious to combine the teachings of Tsukamoto with Murthy et al. to obtain the claimed method in order to reduce leakage current.

The combination of Tsukamoto and Murthy et al. do not suggest the claimed method of manufacturing a semiconductor device. Tsukamoto does not cure the deficiencies of Murthy et al. Tsukamoto does not suggest forming supersaturated dopant concentration source/drain extensions in the substrate between the source/drain regions and the gate electrode, and forming metal silicide contacts on the upper surfaces of the gate electrode and the substrate in a manner sufficient to maintain the supersaturated dopant concentration in the source/drain extensions, as required by independent claim 1. Tsukamoto teaches away from forming supersaturated source/drain extensions, as Tsukamoto expressly teaches forming Lightly Doped Drain-source (LDD) that undergo high temperature annealing (column 4, lines 3-11). Furthermore, Tsukamoto teaches exposing the source/drain regions to laser radiation, not the source/drain extensions, as required by claim 8.

A prior art reference must be considered in its entirety, i.e., as a **whole**, including portions that would lead away from the claimed invention. Such a teaching away from a claimed invention constitutes potent evidence of non-obviousness. See, for example, *In re*

Bell, 991 F.2d 781, 26 USPQ2d 1529 (Fed. Cir. 1993); *In re Hedges*, 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986); *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984). Tsukamoto teaches forming LDD regions that undergo high temperature anneal. Hence, Tsukamoto teach away from the claimed method, and it would not be obvious to combine Tsukamoto with Murthy et al. to achieve the claimed method.

Claims 4, 12, and 13 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai in view of Hsu (U.S. Patent No. 5,491,099). This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested. The following is a comparison between the invention as claimed and the cited prior art.

An aspect of the present invention, per claim 12, is method of manufacturing a semiconductor device comprising providing a silicon-containing semiconductor substrate and forming a gate oxide layer on the semiconductor substrate. A conductive gate material layer is formed over the gate oxide layer. The gate material layer and gate oxide layer are patterned to form a gate electrode having an upper surface and opposing side surfaces, with a gate oxide layer thereunder. A layer of insulating material is deposited over the gate electrode and semiconductor substrate. The insulating material is patterned to form sidewall spacers on the opposing side surfaces of the gate electrode. Source/drain regions are formed by ion implanting a dopant into the substrate. The sidewall spacers are removed and the substrate is heated to activate the source/drain regions. A supersaturated dopant concentration source/drain extensions are formed between the gate electrode and source/drain regions. A second layer of insulating material is deposited over the gate electrode and semiconductor substrate. The second layer of insulating material is patterned

to form sidewall spacers on the opposing side surfaces of the gate electrode. A metal layer is deposited over the gate electrode upper surface, sidewall spacers, and substrate upper surface. The metal layer is heated at a temperature to react with underlying silicon to form metal silicide contacts on the gate electrode and substrate upper surfaces without reducing the dopant concentration in the source/drain extensions below a supersaturated dopant concentration. The metal that did not react to form metal silicide is removed.

The Examiner acknowledged that Bai does not disclose removing the spacers prior to forming the source/drain extensions. The Examiner relied on Hsu to provide a teaching of removing spacers prior to forming source/drain extensions and subsequently forming second sidewall spacers. The Examiner concluded that it would have been obvious to combine the teachings of Hsu with Bai to obtain the claimed method in order to reduce the risk of hot electron reliability failures.

The combination of Hsu and Bai does not suggest the claimed method of manufacturing a semiconductor device. Hsu does not cure the deficiencies of Bai. Hsu does not suggest forming supersaturated dopant concentration source/drain extensions in the substrate between the source/drain regions and the gate electrode, and forming metal silicide contacts on the upper surfaces of the gate electrode and the substrate in a manner sufficient to maintain the supersaturated dopant concentration in the source/drain extensions, as required by independent claims 1 and 12. Hsu teaches away from forming supersaturated source/drain extensions, as Hsu expressly teaches forming lightly doped drains (LDD) that are subsequently exposed to high temperature (column 4, lines 3-14).

A prior art reference must be considered in its entirety, i.e., as a **whole**, including portions that would lead away from the claimed invention. Such a teaching away from a

claimed invention constitutes potent evidence of non-obviousness. See, for example, *In re Bell*, 991 F.2d 781, 26 USPQ2d 1529 (Fed. Cir. 1993); *In re Hedges*, 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986); *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984). Hsu teaches forming LDD regions that are subsequently exposed to high temperature. Hence, Hsu teaches away from the claimed method, and it would not be obvious to combine Hsu with Bai to achieve the claimed method.

Furthermore, Hsu discloses first forming the silicide contacts and then subsequently removing the first sidewall spacers (column 3, line 46 to column 4, line 2), whereas claims 4 and 12 require that the silicide contacts are formed **after** the first sidewall spacers are removed.

Claims 10 and 11 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai in view of Ozturk et al. (U.S. Patent No. 5,242,847). This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

The Examiner acknowledged that Bai does not disclose forming the source/drain extensions by doped selective epitaxy, as claimed. The Examiner relied on Ozturk et al. to provide a teaching of doped selective epitaxy. The Examiner concluded that it would have been obvious to combine the teachings of Ozturk et al. with Bai to obtain the claimed method in order to form doped shallow regions.

The combination of Ozturk et al. and Bai does not suggest the claimed method of manufacturing a semiconductor device. Ozturk et al. do not cure the deficiencies of Bai. Ozturk et al. do not suggest forming supersaturated dopant concentration source/drain extensions in the substrate between the source/drain regions and the gate electrode, and

forming metal silicide contacts on the upper surfaces of the gate electrode and the substrate in a manner sufficient to maintain the supersaturated dopant concentration in the source/drain extensions, as required by independent claim 1.

Claims 14 and 15 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai in view of Hsu and further in view of Ozturk.

Claims 16 and 17 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai in view of Hsu and further in view of Tsukamoto.

Claim 18 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Bai in view of Hsu and further in view of Murthy et al.

These rejections are traversed, and reconsideration and withdrawal thereof respectfully requested. As explained above, Bai, Hsu, Ozturk, Tsukamoto, and Murthy et al., whether taken alone, or in combination, do not suggest the claimed methods.

The dependent claims further distinguish the claimed invention. For example, claim 2 requires that the temperature is maintained below 700 °C throughout the forming of the metal silicide. Claim 3 requires that the metal silicide contacts are made of NiSi. Claim 6 requires that the nickel layer is heated at a temperature of about 400°C to about 600°C for about 15 seconds to about 120 seconds to form NiSi contacts. Claims 7 and 18 further require that the dopant concentration in the source/drain extensions is about 10^{21} ions/cm^3. Claims 9 and 17 further require that the source/drain extensions are formed at an ion implantation dosage of about $1x10^{14}$ ions/cm^2 to about $1x10^{16}$ ions/cm^2 and an ion implantation energy of about 1 keV to about 50 keV, and with a laser radiation energy density of about 0.1 J/cm^2 to about 5.0 J/cm^2. The cited prior art does not suggest the claimed invention with these additional limitations.

In light of the amendments and remarks above, this application is in condition for allowance, and the case should be passed to issue. If there are any questions regarding this Amendment or the application in general, a telephone call to the undersigned would be appreciated to expedite the prosecution of the application.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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